

BEYOND
SMART CITIES

**TECHNOLOGY FOR SUSTAINABLE
DEVELOPMENT
REFRESHER TRAINING COURSE**
KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP





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**SELF-POWERED BUILDINGS
FOR BUILDING SCIENCE PROFESSIONALS**
KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP
BUILDING SCIENCE SPECIALIST CURRICULUM





WHAT SHOULD YOU LEARN



**What are self sufficient
buildings?**
**Smart Energy Self-Sufficient
Buildings**
**Smart Energy Self-Sufficient
Buildings - Problem statement**
**Definition of Energy Self-
Sufficient Building**
**Steps toward a self-sufficient
building**
**Tools and Equipment to be
Considered**



WHAT ARE SELF SUFFICIENT BUILDINGS?



An Energy self-sufficient building is a promising solution that each building can produce its own energy without the need for an external source. In this way, buildings can be considered as autonomous and self-sufficient units without a need to build or invest in transmission and distribution infrastructures.

Nowadays, energy demand is increasing rapidly worldwide due to the unprecedented comfortable lifestyle that people are becoming familiar with.



SMART ENERGY SELF-SUFFICIENT BUILDINGS



Steps toward The newly introduced heavy electrical loads such as electric vehicles and battery storage systems require much energy.

The main problem is that they can introduce peak demands in certain periods, which would affect the stability of the grid.

To solve this problem, renewable energy sources such as PV, wind turbines, concentrated solar power technologies are promoted.



PROBLEM STATEMENT



In the last decades, there were many attempts to go a further step toward sustainable cities and to shift from traditional fossil-based to renewable-based power plants. After recent natural disasters, such as wildfires in Australia and Amazon caused by climate change, it has been realized that more efforts are needed to shift to a greener and sustainable community with less impact on nature and the environment.

One of the solutions is to integrate renewable energy technologies into buildings. This allows a local energy production, which may supply part of the energy demand of the building.

Hence, it is necessary to work on a more sophisticated building that can be self-sufficient in terms of energy without the need to buy energy from the grid.



DEFINITION OF ENERGY SELF-SUFFICIENT BUILDING

Energy Self-Sufficient is the ratio between energy generation and consumption during a certain period. A ratio equal to one means that the generated energy is equal to the consumed energy for a period of time. A ratio lower than one means that the generated energy is not sufficient to supply the total energy demand of the building during this period. Hence, additional energy is required to be supplied by external sources, such as the distribution grid. A ratio higher than one means that the building is generating energy more than its demand. Hence, the additional generated energy is either sold to the power grid or stored in energy storage systems, such as batteries or phase-change materials, etc.



STEPS TOWARD A SELF-SUFFICIENT BUILDING

Two main goals should be attained to maximize the energy self-sufficient building ratio.

1. Minimize the energy demand in a building by:

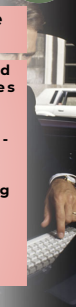
- ☑ Using highly efficient electrical appliances, which may reduce energy use by about 20-30%
- ☑ Using motion and occupancy sensors, which can detect the movement of the residents and act accordingly by turning on/off some appliances. Thus, it saves about 20-40% of energy
- ☑ Applying smart building/home energy management systems and optimization algorithms, which control and schedule the power consumption of electrical appliances and equipment. This may reduce energy waste and increase the efficiency of the building.



STEPS TOWARD A SELF-SUFFICIENT BUILDING+

2. Maximize energy production from renewable sources by:

- ☑ Using rooftop, facades, and windows to install solar and other renewable energy technologies. These technologies can be PV, wind turbines, or concentrated solar power technologies.
- ☑ Using energy storage systems, such as batteries, phase-change materials, or solar water heater.
- ☑ Using highly efficient renewable energy technologies which may increase the local energy production by using the same surface
- ☑ Using optimization algorithms to choose the best renewable energy technology and model for a specific building in a way to minimize the investment cost, payback period and maximize energy production.



TOOLS AND EQUIPMENT TO BE CONSIDERED

To minimize the energy consumption in buildings following tools can be used: motion sensors, current and voltage sensors, smart meters, highly energy-efficient appliances, such as LED bulbs instead of fluorescent and incandescent bulbs, star energy appliances (save about 30% of energy use), Microcontrollers (ESP32, Raspberry Pi, DSP), internet. Additionally, energy storage systems can be installed, such as batteries and phase-change materials. Besides the hardware, a software is also needed to program the energy management system.

To maximize energy production in buildings, renewable energy technologies can be installed on the rooftop, facades, and windows. For example, photovoltaics, wind turbines, dish Stirling, solar water heaters can be installed on the rooftop. The photovoltaic film is used for windows. Building-integrated PV and thermal systems are installed on facades. Waste to energy micro plants are installed inside the building.



FINAL STATEMENTS

An Energy self-sufficient building is a promising solution that each building can produce its own energy without the need for an external source. In this way, buildings can be considered as autonomous and self-sufficient units without a need to build or invest in transmission and distribution infrastructures. The only limitations and barriers to attaining such a self-sufficient building are the low efficiency of renewable energy technologies and the high price of batteries.

Fortunately, in the future, when the commercialized PV system has a higher efficiency over 40% as in the laboratories, the energy -self-sufficient building concept would become a reality not only for small buildings but also for large buildings.



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THANK YOU

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